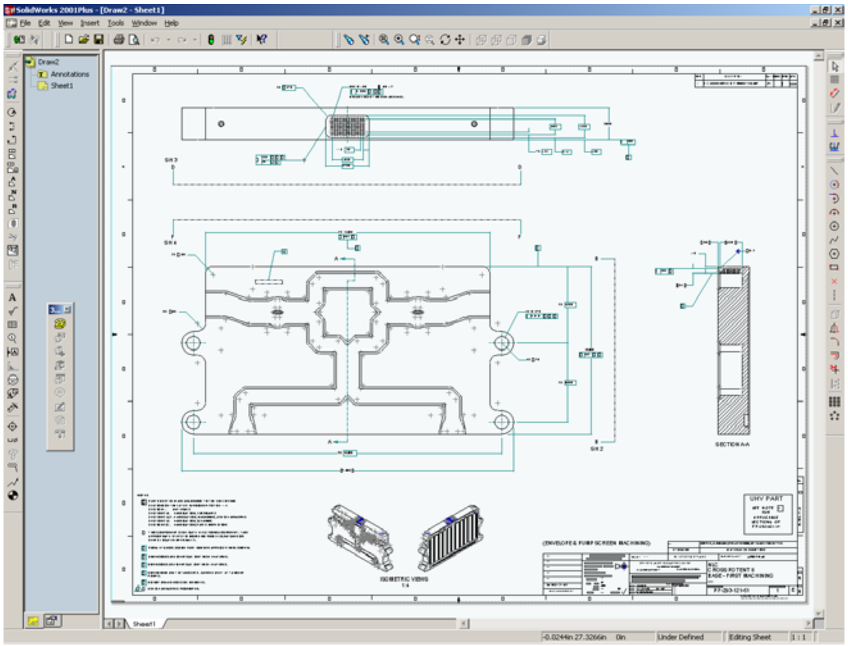
The "Partnering" Concept at The National Labs: A Tangible Example

In June 2002 the first meeting of the National Laboratories Manufacturing / Fabrication Peer Group was conducted in Oakridge, Tennessee. With minor exceptions virtually every major national lab was represented. In addition to establishing personal contacts a number of what were thought to be common topics / problems were discussed. One of the major topics of the meeting was the concept of "partnering". Partnering as a way to mitigate drastic fluctuations in work load as large programs come and go as well as a vehicle for effectively using the unique capabilities within the National Lab system. Discussions revealed numerous organizational and financial obstacles at each Lab in bringing the concept to fruition, however, it was unanimously agreed that the goal was laudable and should be pursued because "World class science does indeed deserve world class support". That is to say, for 21st Century science to be successful, significant collaboration in all areas is a critical cornerstone. A goal for the Design & Fabrication Department at LBNL is to partner with other national labs in areas where unique skills and equipment can be leveraged efficiently. During this past fiscal quarter, the Department has shown that these lofty objectives are indeed possible.

The Stanford Linear Accelerator Center (SLAC) specializes in design, construction and operation of state-of-the-art electron accelerators and related experimental facilities for use in high-energy physics and synchrotron radiation research. In late August 2002 SLAC engineers (Carl Rago et al) approached LBNL Design & Fabrication for help in fabricating components for the NLC program. Particularly of interest were tight tolerance parts for the RF transmission segment (NLC 8 Pac) of the new beam line. The NLC power system combines and magnifies the output of eight X-band Klystrons and transports them to the acceleration structures. A single example (Cross Potent Part) is the focus of this article.

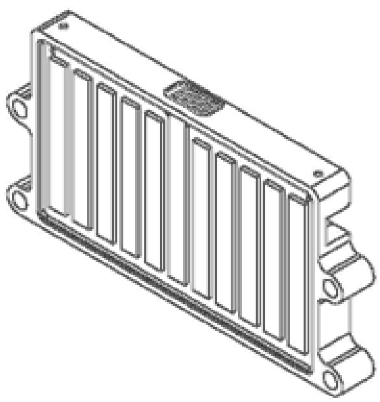
In July a WFO (Work For Others) contract was established with SLAC to cover the financial matters. In the long term, a more comprehensive Master Task agreement should be established through procurement channels, a relatively common practice.

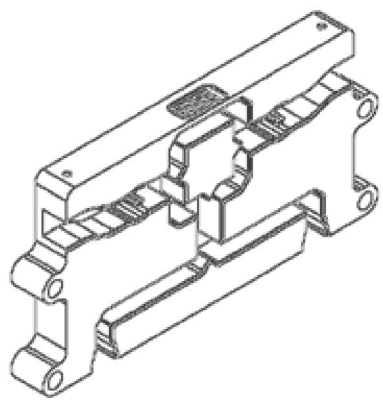
All files were submitted through the Design & Fabrication Department's Web based *Shop Drop* database repository (http://engcad9.lbl.gov/dfd/shopdrop/), with an accompanying Web Job Order manufacturing request (https://www-ia1.lbl.gov/wjo/login.asp). The SLAC engineers submitted all their drawings electronically in three separate formats: Drawing Exchange Format (.dxf), Initial Graphic Exchange File (.igs, .iges) or Standard for the Exchange of Product Model Data (.stp, .step). For future reference to new customers, whenever possible, we are requesting that when they require fabricated parts and/or assemblies for manufacture that they submit electronic versions of the associated drawings.



Use can be made of the native CAD files (Pro/E, Solid Designer, SolidWorks, etc.) as well. For CAM efficiency, all designs should be drawn 1:1 scale.

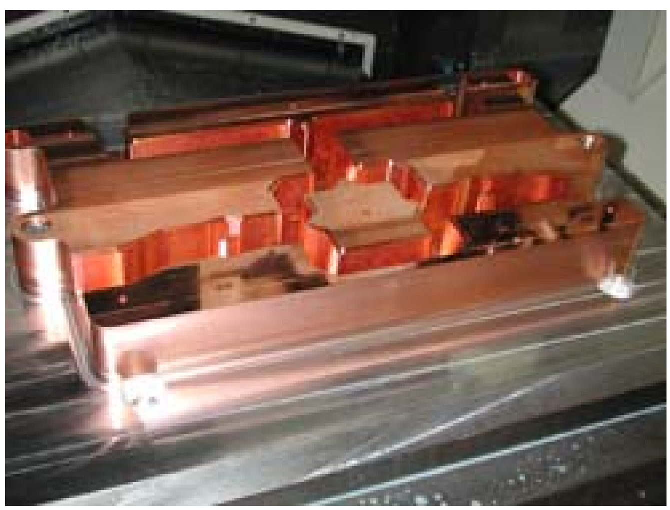
> *Note: Designers must draw with the intent for manufacturing directly from the prints; this means that dimensions must be true. CAM software systems have the ability to close gaps and repair some errors, however duplicate lines and overlapped lines are not acceptable. Output tolerances and parameters must be determined to ensure compatibility with CAD/CAM software.*

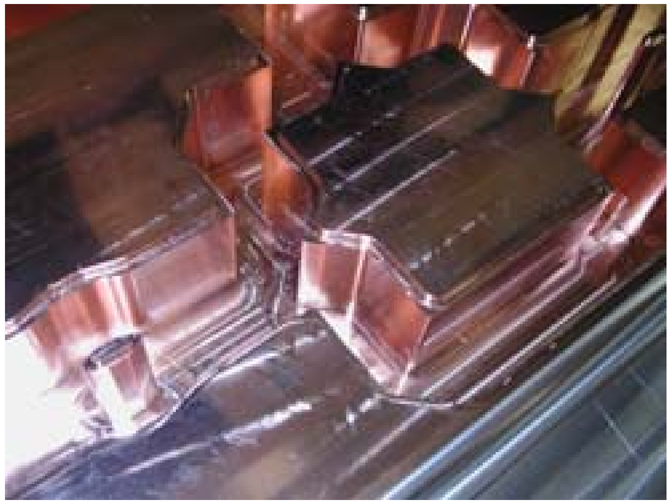




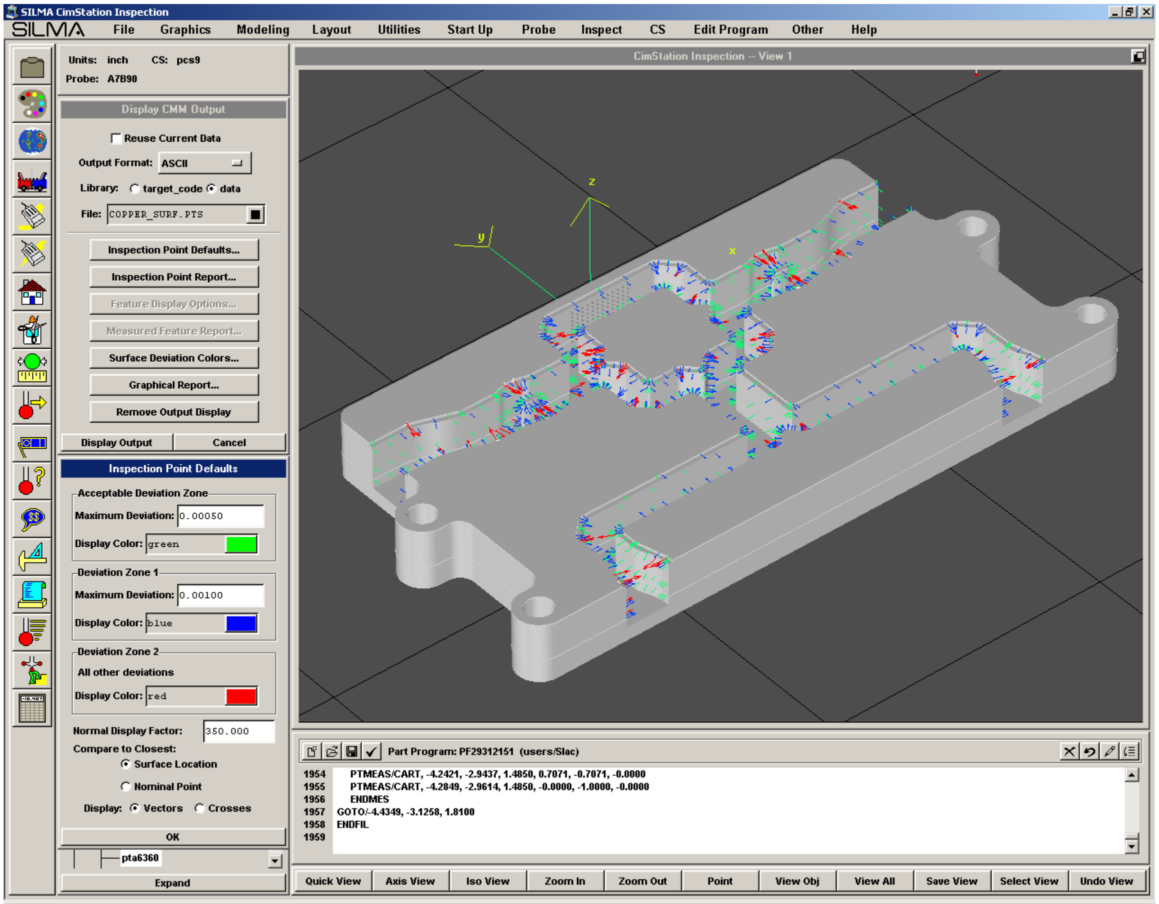
The drawing files were then converted to the necessary numerical code and tool paths using either *Hyperform*™ or *AlphaCam*™ (depending on the complexity of the part). The parts were subsequently fabricated on our new Yasda 950V mill.

The machine is a vertical jig boring machine developed for boring and milling when extremely high accuracy is required. The JIGBORER also performs heavy-duty machining which previously has been impossible with the conventional jigborer.





Following fabrication, the more complex and critical segments of the part were inspected on our coordinate measuring machine (CMM). Shown below is a screen shot of the Cross Potent Part showing the entire *Silma*[m] screen including software point deviation settings.



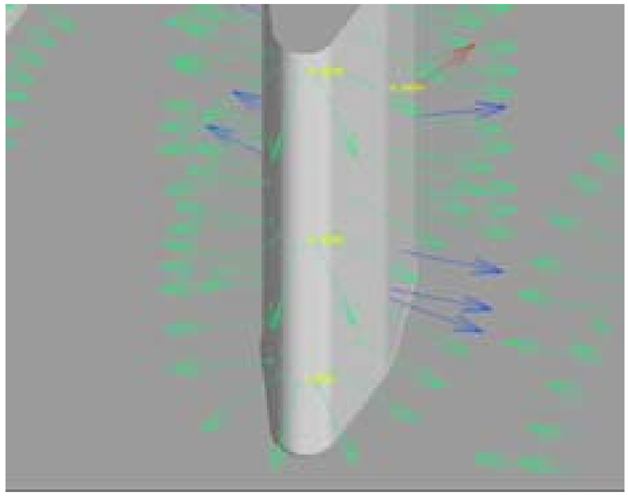
The measured data was compared to the original CAD drawing file using *Silma*™ software.

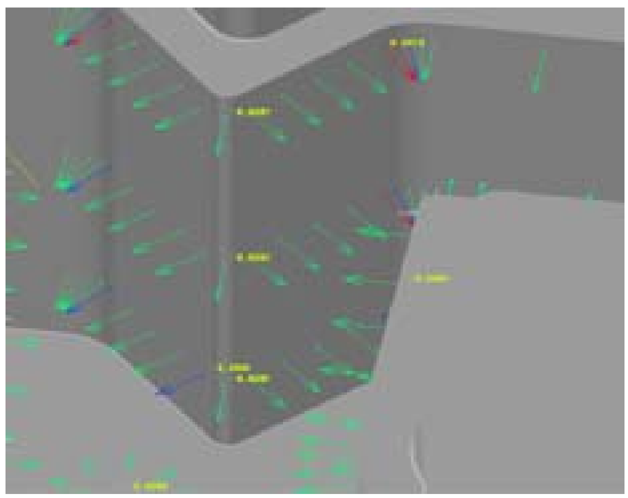
- The X origin is a mid plane constructed from the right and left side planes
- The Y origin is the planer datum C feature
- The Z origin is the planer feature at the bottom of the slots

The arrows on the jpeg's go from the surface to the measured point.

- Green arrows = +/- 0.0005 (Profile of 0.001)
- Blue Arrows = +/- 0.0010
- Red Arrows = >+/- 0.0010

It can be seen that most arrows on the sidewalls point away from the surface. This indicates that the part walls are fat, there is extra material on the walls and the slots are narrow. There is no chatter in the bottom of the slots or sidewalls.





When translating concepts into “hardware”, instantaneous and paperless is the goal. Through this exercise we have shown that electronic drawing submission, use of CAM software, numerically controlled machines, and computer based inspection can successfully be exploited to produce tangible precision parts required by scientific research; independent of location. In other words, the process is feasible and should be used whenever possible within the national laboratory system to fully utilize the unique capabilities of each lab to its fullest extent. SLAC and LBL will continue to work closely to improve upon the partnering process so that the scientific needs of the nation can be rapidly and economically achieved.